MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2015/2016

PCM0035 – GENERAL CHEMISTRY
PCM0016 – CHEMISTRY

(All sections / Groups)

12 MARCH 2016
2.30 p.m - 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 4 pages only excluding the cover page.
2. Attempt **ALL** questions. Distribution of the marks for each question is given.
3. Please write all your answers in the Answer booklet provided.

QUESTION 1 [20 MARKS]

(a) When iron (II) hydroxide is allowed to mix with phosphoric acid, iron (II) phosphate precipitate results. The balanced equation for the reaction is:

$$3\ Fe(OH)_2\ (aq) + 2\ H_3PO_4\ (aq) \rightarrow Fe_3(PO_4)_2\ (s) + 6\ H_2O\ (l)$$

Answer the following questions:
[Atomic Mass: H=1.0; O=16.0; Fe=55.8; P=31.0]

(i) Define precipitate. [1 mark]

(ii) Find the limiting reagent and the reactant in excess if 1.6 g of $Fe(OH)_2$ is treated with 5.2 g of phosphoric acid. [3 marks]

(iii) Based on your answer in (iii), calculate the maximum amount in grams of $Fe_3(PO_4)_2$ precipitate that can be formed. [1.5 marks]

(iv) If 1.98 g of precipitate is actually obtained, calculate the process efficiency. [1.5 marks]

(b) A 50 g sample of thin metal sheet is heated to 98 °C by placing it in a boiling water bath. The metal sheet is removed from the boiling water bath, quickly dried and then placed in a 25 g yellowish solution at 22 °C. The final temperature is 30.7 °C, what is the specific heat of the metal sheet?
[Specific heat for the yellowish solution is 3.81 J/g·°C] [2 marks]

(c) Calculate the standard enthalpy change, ΔH^o, for the formation of 1 mol of carbon and 1 mol of oxygen as in the equation: $CO_2(g) \rightarrow C(s) + O_2(g)$.

Given the equations below:

$2\ H_2O(l) \rightarrow 2\ H_2(g) + O_2(g)$	$\Delta H^o = 1286$ kJ
$C_2H_6(g) \rightarrow 2\ C(s) + 3\ H_2(g)$	$\Delta H^o = 190.6$ kJ
$4\ CO_2(g) + 6\ H_2O(l) \rightarrow 2\ C_2H_6(g) + 7\ O_2(g)$	$\Delta H^o = 7022.2$ kJ

[3.5 marks]

(d) Magnesium reacts with water to form magnesium hydroxide and hydrogen gas.
[Atomic Mass: H=1.0; Mg=24.3; O=16.0]

(i) Write a complete chemical equation for the reaction. [2 marks]

(ii) Determine the mass of water needed to produce 200 L of hydrogen gas at STP. [2 marks]

(e) Given 30 g of ammonia (NH_3) gas, calculate the following:
[Atomic Mass: H=1.0; N=14.0; $N_A = 6.02 \times 10^{23}$]

(i) The number of molecules in 30 g of NH_3 [1 mark]

(ii) The number of H atoms in 30 g of NH_3 [1 mark]

(f) A bag of food has a volume of 2.0 L at 760 torr of pressure. Find the volume in an airplane flying at a high altitude with a pressure of 550 torr. [1.5 marks]

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QUESTION 2 [20 MARKS]

(a) Provide the name, the possible magnetic quantum numbers and the number of orbitals for subshell $n = 3$, $l = 2$. [1.5 marks]

(b) Given an element scandium (Z=21).
(i) Draw the *orbital diagram* for scandium without using a noble gas core. [1 mark]
(ii) Write the electron configuration for scandium by using a noble gas core. [0.5 mark]
(iii) Specify the group of the periodic table in which scandium is found. [0.5 mark]

(c) The elements below belong to the same period. However the symbols for *A*, *B*, *C*, *D* and *E* are not the actual symbols. Answer the questions that follows:

Element	*A*	*B*	*C*	*D*	*E*
Atomic no.	11	13	16	17	18

(i) Name the period of these elements found. [0.5 mark]
(ii) Which element has the highest electronegativity? [0.5 mark]
(iii) Which element has the lowest ionization energy? [0.5 mark]
(iv) Which element is a noble gas? [0.5 mark]
(v) Classify the oxide of element *B* as either acidic, basic or amphoteric. [0.5 mark]

(d) Rank the following ions in the order of increasing atomic radius (from smallest to largest):

K^+ , Cl^- , Ca^{2+} , P^{3-} [1.5 marks]

(e) Draw the Lewis structure for Mg_3N_2. [1 mark]

(f) Name the shape (molecular geometry) and give the AB_mE_n classification for CO_3^{2-}. [2 marks]

(g) The relocation process of methyl isocyanide to form methyl cyanide follows first-order kinetics. The reaction equation is: $CH_3NC(g) \rightarrow CH_3CN(g)$. If the initial concentration of $CH_3NC(g)$ was 0.053 *M* and after 15 minutes, the concentration of product was 3.01×10^{-2} *M*,
(i) Find the value and state the unit of rate constant, *k*. [2 marks]
(ii) Find the half-life (in minutes) of $CH_3NC(g)$ in the reaction. [2 marks]
(iii) How long (in minutes) will it take for 75% of $CH_3NC(g)$ to react? [2 marks]

(h) Identify the relationship between intermolecular forces and viscosity. [1 mark]

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(i) In a study, the following results are obtained for reaction: A + B → C + D. Answer the questions below.

Exp	[A]	[B]	Initial rate of reaction (*M/s*)
1	$2a$	b	x
2	a	$3b$	$2r$
3	$2a$	$3b$	$8r$

(i) What is the order of reaction with respect to A? [0.5 mark]
(ii) Find the value of x if B follows zero-order kinetics. [0.5 mark]
(iii) Find the rate constant if $a = 0.8$, $b = 0.5$ and $r = 25$. [1.5 marks]

QUESTION 3 [20 MARKS]

(a) The pH of a 0.15 M solution of a weak acid, HW, is 2.82 at 400 K.
(i) Write an expression for the acid dissociation constant, K_a, of HW, and determine the value of K_a for this acid at 400 K. [2 marks]
(ii) The dissociation of HW into its ions in aqueous solution is an endothermic process. How would its pH change if the temperature were increased? Explain your answer. [1.5 marks]

(b) For the table below, answer (i), (ii), (iii) and (iv).

Solution	**pH**	**[H^+]**	**pOH**	**[OH^-]**	**Acidic, basic or neutral?**
x	11.7	(i)	2.3	(ii)	-
y	-	(iii)	-	3.79×10^{-7}	(iv)

[2 marks]

(c) A 0.5 *M* acetic acid, CH_3COOH is 9.5% dissociated.
(i) Calculate the pH of the acid. [1.5 marks]
(ii) Calculate the value of K_a for CH_3COOH. [1.5 marks]

(d) Assign oxidation numbers to each element in the following:
(i) H_2S [1 mark]
(ii) MgF_2 [1 mark]

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(e) The table below shows some reduction half-equations and their standard reduction potentials.

Reduction Half-Reaction	E^o_{red}
$Zn^{2+}(aq) + 2e \rightarrow Zn(s)$	– 0.76
$Ag_2O(s) + 2H^+(aq) + 2e \rightarrow 2Ag(s) + H_2O(l)$	+ 0.34
$Li^+(aq) + e \rightarrow Li(s)$	– 3.04
$F_2(g) + 2e \rightarrow 2F^-(aq)$	+ 2.87

(i) Identify the strongest reducing agent from the species in the table. Explain your answer. [1.5 marks]

(ii) Rank all the species from the lowest to the highest oxidizing agent. [1 mark]

(f) The rusting of iron is electrochemical in nature.

(i) Draw a relevant diagram to indicate the rusting of iron. Label the anode and the cathode respectively. [2 marks]

(ii) Write the half equations that occurred at the anode and the cathode. [2 marks]

(iii) State two factors for the rusting of iron to occur. [1 mark]

(g) Determine how long (in hours) must a current of 4 A be maintained to electroplate 60 gram of calcium from molten $CaCl_2$.
[Atomic Mass: Ca=40.0; Cl=35.5; Faraday constant = 96500 C/mol e^-] [2 marks]

End of Paper